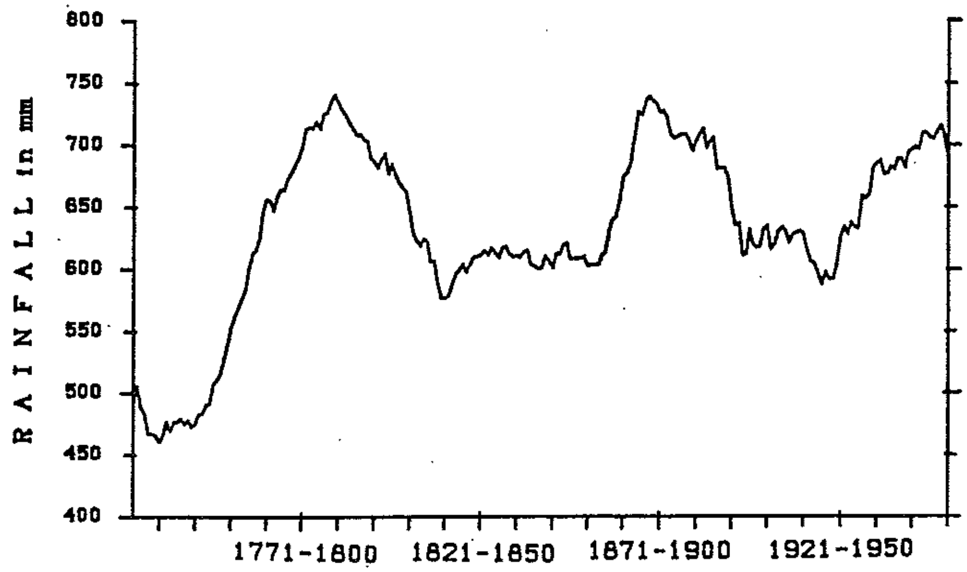

Fig. 5.25. 30-year running means of precipitation at Beijing (from 1724–1980)

fluctuation in recent times (Fig. 5.25). The graphs give evidence of a clearly established precipitation periodicity which expressed three peak and depression periods each. Precipitation peaks were recorded from about 1770–1800, 1860–1890 and 1930–1945. Precipitation depressions were experienced from 1730–1745, 1810–1850 and 1890–1920. It is worth noting the rather large differences in the annual precipitation totals between peak and depression periods and the normally long and significant periods of either ample or scarce precipitation.

5.11 Snow

Representing a type of precipitation during frost temperatures, snow can be expected to depend directly on temperatures below zero which may result from both a higher latitude and a greater elevation above sea level. Both criteria are obviously fulfilled in major parts of China, due to the far-reaching northern extent and the extremely high altitudes. Furthermore, if the vapour content of the air is sufficient for sublimation, conditions for snowfall would be ideally satisfied, thus leading to a greater climatic significance of snow for China.

This assumption is supported by observations of various snow indices, which will be dealt with in detail. Long-term monthly and annual records of snow conditions are included in the climate tables (see Appendix): (1) the number of days of the snow cover period; (2) the number of snowfall days; (3) the maximum depth of snow.

5.11.1 Mean Length of Snow Cover Period

Considering the mean length of the snow cover period, which means the number of days between the (mean) first and last dates of snow cover, considerably large differences over space occur (Fig. 5.26). It can be seen that for all of China the

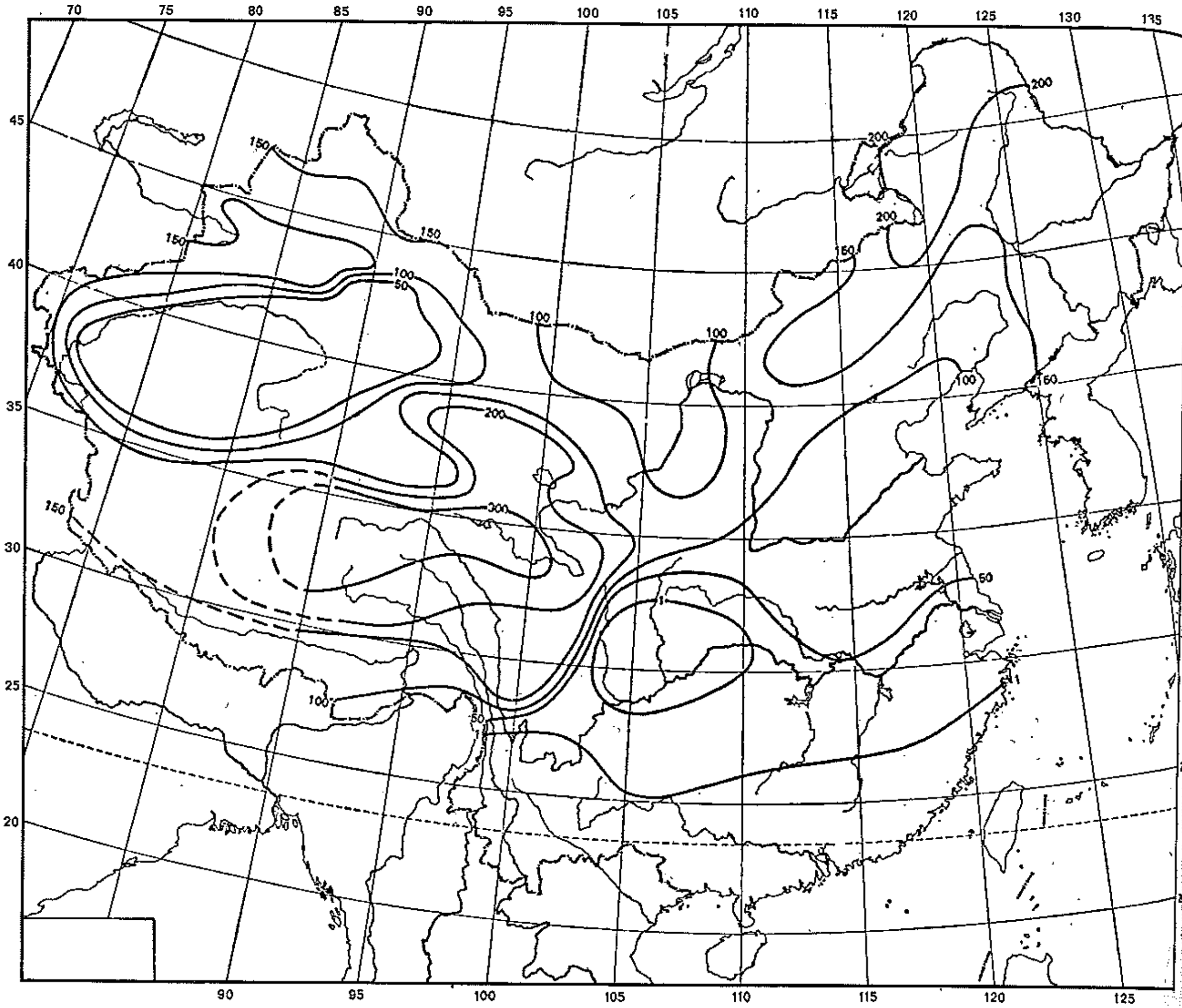

Fig. 5.26. Mean length of the snow cover period, expressed by the number of days between the mean first and last date of snow cover

mean length of the snow cover period varies between less than 1 day and more than 300 days; the recorded maximum figure even amounts to 365 days, valid for the year-round glaciered high-altitude mountains. It thus can be expected that the largest possible range of the length of the snow cover period is valid for China, i.e. completely snow-free conditions throughout the year, on the one hand, to fully snow-covered conditions year-round, on the other. The mean length of the snow cover period at any location plausibly depends on two aspects: (1) its latitudinal position and (2) its elevation above sea level. As can be inferred from the map of the mean length of the snow cover period (Fig. 5.26), a strong latitudinal effect is established over the *eastern* parts of China, showing an increasing length of the snow cover period from south to northeast. While completely snow-free conditions occur in South China, a more than 200-day period of snow cover is valid in Northeast China. A considerable variation of the length of the snow cover period is also observed in the *western* part of China, mostly dependent upon altitudinal differences. The maximum length of the snow cover period, exceeding 200 days (sometimes even 300 days), occurs in Nan Shan, Kunlun Shan and the Tibetan Plateau, while the minimum number of less than 50 snow cover days is observed in the Tarim Basin. The contrasting elevation and vapour content between the two regions lead to completely different thermal and hygric conditions wich are responsible for the formation and type of precipitation.

Excluding the highest mountain regions (which experience a year-round snow cover period), the longest recorded duration of the snow cover period occurs in the mountains of Qinghai and (West) Sichuan as the following stations demonstrate:

Station	Elevation (m a.s.l.)	Mean date of first/ last snow	Days
Da Qaidam/259	3,173	Sept. 30, June 13	257
Tongde/246	3,289	Sept. 16, June 22	280
Yushu/243	3,703	Sept. 15, June 11	270
Litang/231	3,949	Sept. 03, June 17	288

Due to the high elevation of the stations under consideration, the altitudinal impact on snow conditions may be responsible for the great length of the snowfall period, although the mean annual number of snowfall days does not clearly underline this assumption (cf. Sect. 5.11.2). However, the considerably large difference between the length of the snow cover period and the number of snowfall days can be taken as proof of the great variability of snowfall as far as the first and last dates of snowfall are concerned.

While the observations given so far refer to the *possible* maximum lengths of the snow cover period only, the recorded number of days with snow cover shows much smaller values and represents a more realistic picture of snow conditions. The distribution of the mean number of days with snow cover (Fig. 5.27) shows an extremely variable pattern over space. In eastern China, the recorded number of snow cover days decreases from >150 in northeasternmost China to <0.1 in southern China. In addition, also in western China the number of days with snow cover vary between >100 and <10. As in the case of the mean length of the snow cover period (cf. Fig. 5.26), also the distribution of the number of snow cover days shows a strong impact with altitude. Locations at higher latitude and high altitude experience a larger number of snow cover days, while locations at lower latitude and low altitude record a small number; in this case the number of snow cover days even falls <0.1.

Corresponding to the considerably large differences over space with regard to the length of the snow cover period and the recorded number of days with snow cover, the dates of the first and last snow also vary considerably, both in terms of latitude and altitude above sea level. Generally, snow is experienced earlier and lasts longer with increasing latitude. The same observations are true for increasing elevation above sea level.

The latitudinal differences in the first and last dates of snow can be clearly seen along a north to south cross-section through the eastern parts of China (Table 5.22).

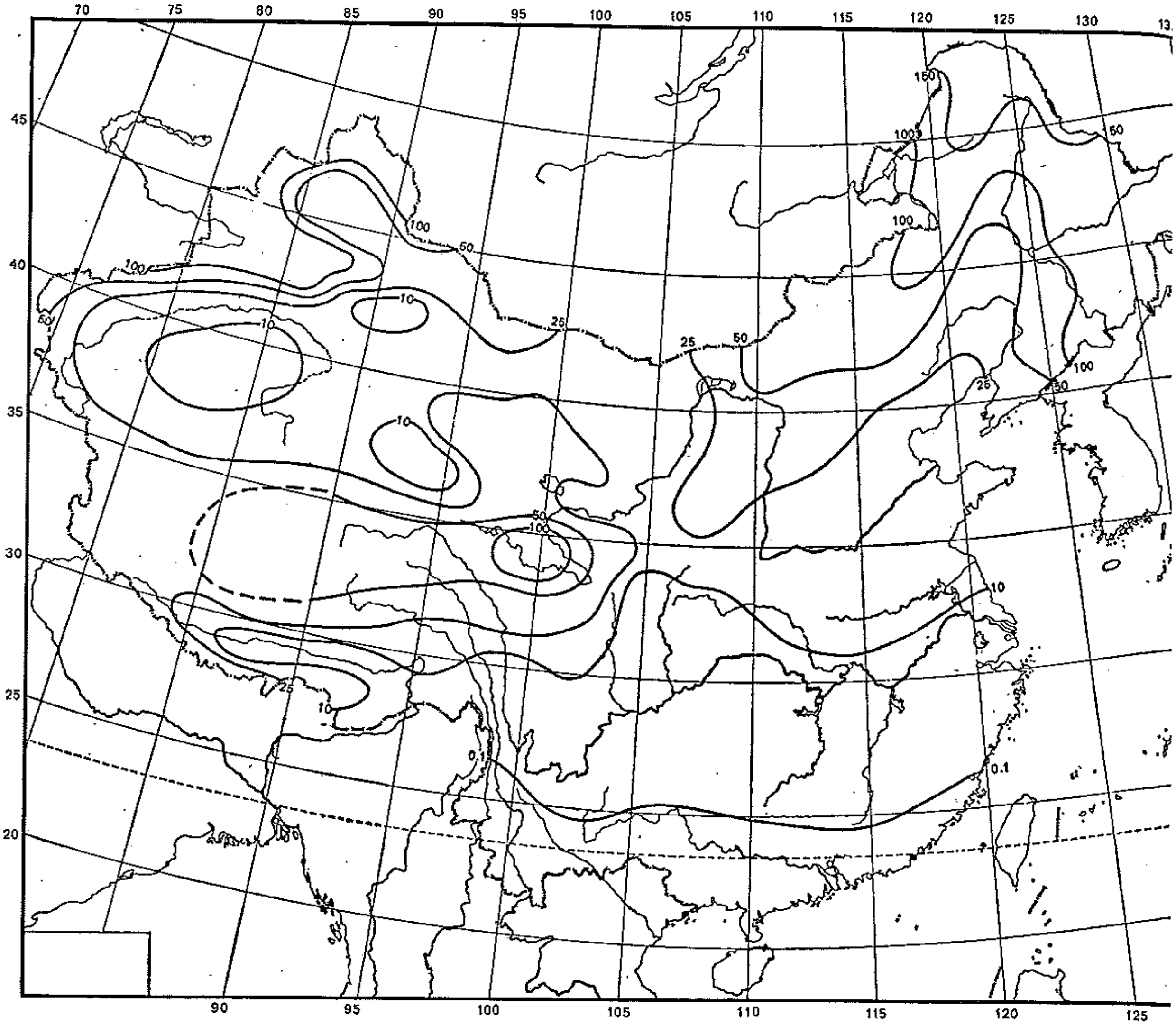

Fig. 5.27. Mean number of days with snow cover

Table 5.22. First and last dates of snow, mean length of the snow cover period and number of snow cover days at selected stations along a north to south cross-section through the eastern parts of China

Station/No.	Lat. °N	First snow	Last snow	Snow cover days	Snowfall days
Mohe/1	53	27.09.	14.05.	175.9	47.2
Harbin/15	46	15.10.	19.04.	105.1	33.1
Changchun/27	44	14.10.	21.04.	88.4	27.1
Shenyang/38	42	25.10.	13.04.	61.5	20.5
Beijing/61	40	26.11.	19.03.	15.6	9.5
Shijiazhuang/70	38	27.11.	14.03.	18.4	10.6
Jinan/77	37	30.11.	22.03.	14.6	9.3
Zhengzhou/90	35	1.12.	15.03.	14.8	10.9
Nanjing/116	32	14.12.	10.03.	8.9	8.4
Shanghai/119	31	5.01.	11.03.	3.2	5.5
Hangzhou/123	30	20.12.	11.03.	7.8	9.8
Wuhan/126	30	6.12.	4.03.	8.9	9.2
Changsha/147	28	20.12.	28.02.	6.1	8.8
Fuzhou/183	26	–	–	0	0.8
Guangzhou/199	23	–	–	0	0

5.11.2 *Number of Snowfall Days*

As a result of the disrupted pattern of temperature and precipitation in China, the number of snowfall days varies to a large extent over space (see the corresponding figures in the climate tables, Appendix). A snowfall day is characterized by any precipitation of a snow type.

The distribution of the (mean) number of snowfall days corresponds to the same two principles as for the length of the snow cover period, i.e. the clear relationship with both latitude and altitude (see Sect. 5.11.1). Southern China records the smallest number of snowfall days (<1), whereas in Northeast China at the most <60 snowfall days are experienced. The absolutely highest figure (>100 snowfall days) is valid for the eastern part of the Kunlun Shan. It is, however, worth noting that the number of snowfall days over western China varies considerably over space. The absolutely smallest number is true for the Turpan depression (<1 snowfall day), but also the whole Tarim Desert as well as the Gobi Desert and even parts of the southeastern Tibetan Plateau record <10 snowfall days.

The increasing number of snowfall days with increasing latitude in eastern China is clearly shown for selected stations at different latitudes (see Table 5.23). At the same time, the different annual variation of snowfall days is underlined. It is also noteworthy that the peak months of snowfall shift from November and December (at Mohe/1) to December and January (at Harbin/15), and to February and March (at Beijing/61 and Shanghai/119). Guangzhou/199 experiences no snowfall at all.

Table 5.23. Mean monthly number of snowfall days and length of the snow cover period at selected stations at different latitudes

	S	O	N	D	J	F	M	A	M	Annual No. of snowfall days	Length of snow cover period (days)
Mohe	0.9	6.1	9.0	8.8	6.0	6.5	5.6	5.1	1.0	49.0	230.4
Harbin	0.1	1.6	5.1	6.0	7.0	4.9	4.8	1.6		31.1	183.1
Beijing			0.8	0.8	1.6	3.3	3.3	0.1		9.9	109.0
Shanghai				0.5	1.7	3.1	0.8	0.2		6.3	78.0
Guangzhou										0	0

Looking individually at the number of snowfall days for the stations of the mountainous western parts of China (see climate tables, Appendix), snowfall conditions vary considerably and thus underline a strong influence of the altitude and landforms on the snow conditions as can be seen at the following stations:

Station	Elevation (m a.s.l.)	Mean annual No. of snowfall days
Songpan/102	2,828	47.3
Tongde/246	3,289	32.4
Garze/233	3,394	33.4
Deqen/230	3,589	56.4
Yushu/243	3,703	37.3
Litang/231	3,949	46.4

In contrast, stations at a high elevation may also experience a small number of snowfall days only as also stations at a comparably low elevation may record a large number of snow days. Both observations can be seen for stations in central and western China:

Station	Elevation (m a.s.l.)	Mean annual No. of snowfall days
Lenghu/260	2,733	2.4
Xigaze/238	3,836	6.2
Golmud/258	2,808	7.2
Lhasa/239	3,658	8.3
Da Qaidam/259	3,173	12.8
Jiulong/137	2,987	13.8
Altay/270	735	37.8
Ürümqi/269	654	46.5

Moreover, it is worth noting the extremely low number of snowfall days even at very high altitudes (see Xigaze/238, 3,836 m; Lhasa/239, 3,658 m). In the Tibetan Plateau, the surrounding high mountains act as barriers against the cold northerlies, thus leading to poor snow conditions. Evidence of the severe influence of cold waves on the snow conditions is given at Ürümqi/269 and Altay/270, which lie at a rather low altitude (654 and 735 m above sea level respectively), but due to their windward location they still record a large number of snow days (46.5 and 37.8 respectively).

The strong heating effect, exerted by orographical depressions and hence leading to a heat surplus, contributes to a small number of snowfall days, proof of which is given at Turpan/267 (at 34.5 m above sea level, 4.5 snow days) and Ruoqiang/264 (888 m, 4.1 snow days). Additionally, precipitation in the desert is very low and subsequently the snowfall activity is depressed.

5.11.3 Maximum Depth of Snow

The data for maximum depth of snow are also included in the climate tables (see Appendix). It can be deduced that the maximum depth of snow varies over space, yet the variation does not clearly correspond to the variations already shown in the case of the length of the snow cover period and the number of snowfall days (cf. Sect. 5.11.1 and 5.11.2).

When considering the distribution of the maximum depth of snow over space, the largest values occur in the Tian Shan and Altay (>50 cm). It is noteworthy that the Tibetan Plateau, including the surrounding high-altitude mountains, records a comparably small value for the maximum depth of snow, mostly around 10 cm. With the exception of northernmost China, there are no major differences in the maximum depth of snow, which may result from the different altitudes and landforms in western China. Over eastern China, the distribution of the maximum depth of snow shows major variations over space, but a close relationship to latitude cannot be found. Principally, however, remarkably large differences over space occur for the maximum depth of snow showing larger values for Northeast China (up to >40 cm) and the smallest values for South China (<1 cm), yet a true correlation with latitude cannot be proved.

5.11.4 Altitude of the Snow Line

For such an extremely mountainous country as China, the snow line represents a most important hygro-climatic index. It also relies on the permanent snow and ice coverage, including glaciers. The drastic extent of snow and ice is emphasized by the fact that the Qinghai-Xizang Plateau with its surrounding high mountains, including the Himalayas, Karakorum, Pamir, Kunlun, Qilian and Hengduan Mountains, is the most extensive area of mountain glaciers on earth. In the last three decades, a number of Chinese expeditions of the glaciers in Qilian, Central Himalayas, East Pamir and Karakorum have been carried out and have enabled a comprehensive report on the basic features of the glaciers on the Qinghai-Xizang Plateau and the surrounding mountains (see in particular SHI Ya-feng and LI Ji-jun, their results are particularly quoted in this section).

The total area above the snow line, representing the glaciered area, amounts to about 56,500 km^2, of which 46,640 km^2 (83%) belong to the glaciers of the Qinghai-Xizang Plateau in the Chinese territory (Table 5.24, according to SHI Ya-feng and LI Ji-jun 1981). In comparison with the total glaciered area of High Asia, which was estimated at about 100,000 km^2 (VON WISSMANN 1959), about one-half belongs to the Chinese part of the Qinghai-Xizang Plateau.

The development and distribution of glaciers in the Qinghai-Xizang Plateau and its surrounding mountains are influenced greatly by the spectacular elevation, topography and particular climate of the Plateau. The height of the snow line varies from 4,400 in East Qilian Mountain and southeastern Xizang to 6,000–6,200 m in southern and western Xizang, and the isolines of the snow line show some irregular concentric circles with their centre in southwestern Xizang (Fig. 5.28). These peculiar variations of the snow line are mainly due to the rapidly decreasing precipitation as well as intensification of the thermal plateau effect between some outer mountains and the inner part of the Qinghai-Xizang Plateau. The annual total of precipitation in the glaciered area of East Qilian Mountain amounts to 800 mm, but 2,000 mm in southeastern Xizang, decreasing

Table 5.24. Glaciered area on Qinghai-Xizang Plateau in China. (After SHI Ya-feng and LI Ji-jun 1981)

Mountains	Height of snow line	Area of glacier (km²)
Qilian	4,300 – 5,200	1,973
Kunlun	4,700 – 5,800	11,639
Pamirs	5,500 – 5,700	2,258
Karakorum	5,100 – 5,400	3,265
Qiangtang Plateau	5,600 – 6,000	3,188
Tanggula	5,400 – 5,700	2,082
Gandise	5,800 – 6,000	2,188
Nyainqen tanglha	4,200 – 5,700	7,536
Hengduan Mountains	4,600 – 5,600	1,456
Himalayas	4,300 – 6,200	11,055
		Total: 46,640

to 200–300 mm in central and western parts of the Plateau (SHI Ya-feng and LI Ji-jun 1981). As can be seen, the snow line on the southern slope of the Himalayas is lower than on the northern which is due to the differences in precipitation (Fig. 5.28). The peculiar conditions of solar radiation in the Qinghai-Xizang Plateau, in comparison with the surrounding lowlands, apparently influences the height of snow lines. Due to the vast extent of the Plateau, extremely high totals of radiation are absorbed by the Plateau which in its central and western parts record the highest values in all of China, so that the height of the snow lines is elevated.

The distribution of the glaciered area in the Qinghai-Xizang Plateau is uneven. The largest glaciered areas, which occupy the Karakorum, Pamir and West Kunlun, are located in the western borderlands of the Plateau where its considerable elevation compels the prevailing westerlies with high vapour content which leads to much precipitation (snow) in the glaciered areas. Although the deep valleys are characterized as very dry areas, the annual total of precipitation at 5,500 m elevation of the Fedschenko Glacier of West Pamir and the Batura Glacier of West Karakorum reaches about 1,500 mm or more. The second glaciered area, which includes Nyainqentanglha and the eastern end of the Himalayas, presents favourable conditions for the passage of moisture-laden air masses of the Indian Southwest monsoon. Therefore, from May through September clouds cover this area densely and heavy snowfalls frequently occur in the high mountains. Through intense glaciological research in China, it was also found for the southern slopes of the Himalayas as well as the northern slopes of Tian Shan that two maximum precipitation belts exist in the glaciered mountain areas. The lower belt of maximum precipitation is at 1,500–2,000 m above sea level. Above this elevation, the amount of precipitation decreases, but increases again and reaches its second belt of maximum precipitation in the glaciered height of more than 4,200 m above sea level. This interesting distribution of precipitation results from the conditions of local convection by strong solar radiation in the day-time (according to investigations by the Lanzhou Institute of Glaciology 1975).

The intensification of glaciological research in China has led also to interesting results on the variation of glaciers. Mainly based on the comparison of aerial

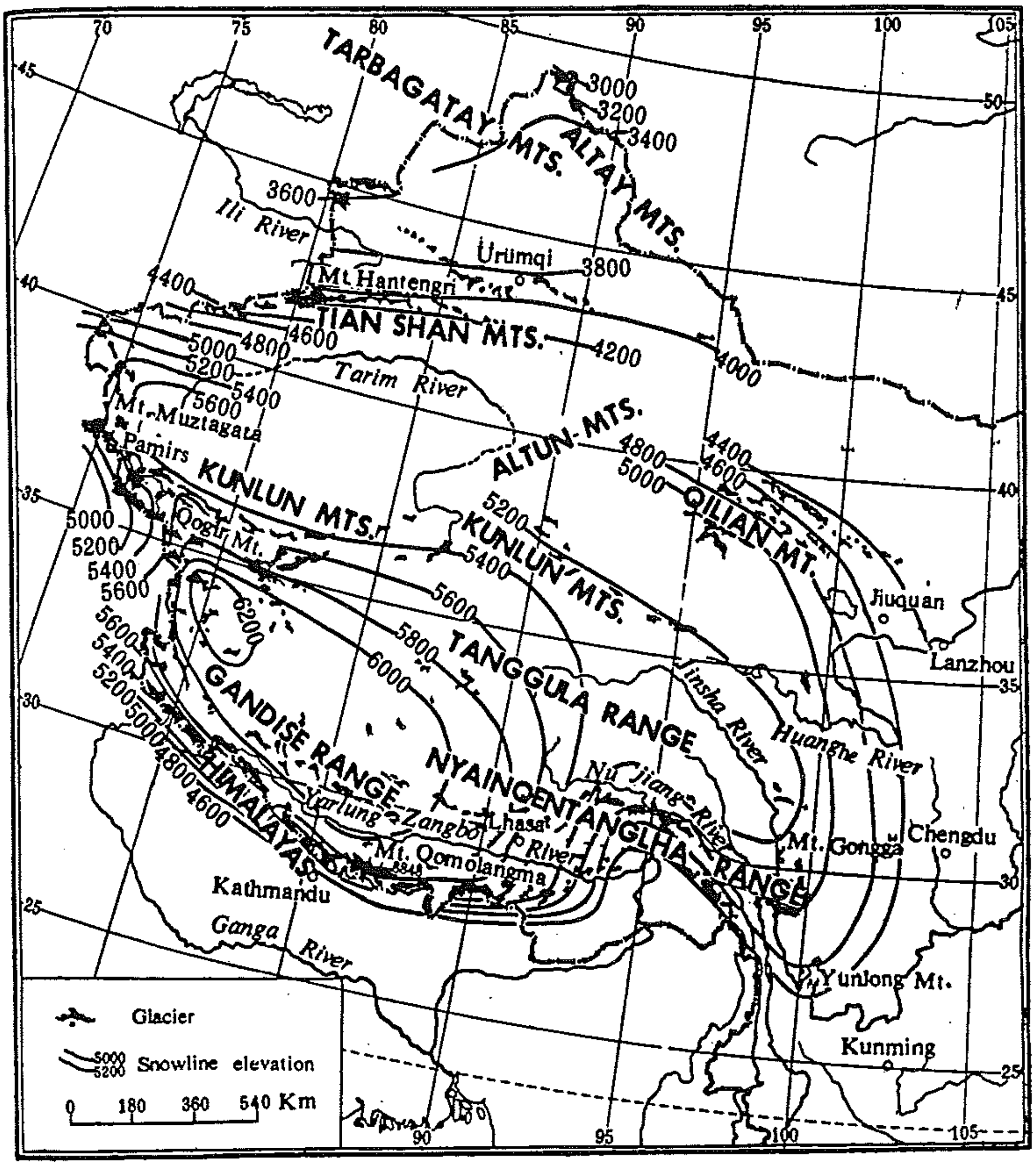

Fig. 5.28. The heights of the snow line in China. (After SHI Ya-feng and LI Ji-jun 1981)

maps of the 1960s with Landsat images of the 1970s, it was found that among the 116 glaciers on the Qinghai-Xizang Plateau, 35 are advancing, 62 retreating and 9 are stable or without a major variation (SHI Ya-feng and LI Ji-jun 1981). According to studies on the distribution of glaciers and the height of the snow line in the Qilian Shan for the last 1,000 years (LIU Guangyuan et al. 1984), glaciers advanced between 1500 and 1900, retreated between 1920 and 1960 and again increased since the 1970s. Accordingly, the snow line varied in its elevation.

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